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Abstract. This paper identifies pivotal factors behind individual decision-making in the transition from high school to post-secondary education in the Netherlands. We apply a multinomial logit framework to individual data on post-secondary education choices. Specifically, our modeling approach accommodates two types of effects that have not received ample attention in the literature. First, we include information regarding the geographical accessibility of the higher education system. Second, we allow the individual observations to be correlated within schools in order to account for localized social interactions. Our results confirm the paramount influence of the student's track record and talent. The results, however, also show that geographical proximity to universities or professional colleges significantly increases the probability of high school leavers continuing their education at the post-secondary level.

JEL classifications: C25, I21, R10

Key words: high school graduates, higher education, social interaction, geographical accessibility

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1. Introduction

The behavior of high school leavers with respect to the choice between continuing education by entering post-secondary schools or entering the labor market has been analyzed quite thoroughly. Initially, studies assumed the choice to be a simple binary decision between continuing schooling or entering the labor market (see, for instance, Kohn et al., 1976). More recently, studies have considered broader sets of alternatives

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including vocational education options and labor market alternatives, and have analyzed the choice behavior by means of multinomial models (see, for instance, Riphahn, 2002; Nguyen and Taylor, 2003; Giannelli and Monfardini, 2003).

The transitional behavior of high school leavers is generally explained by individual characteristics, such as the individuals' capabilities, as well as the students' socio-economic background, usually measured by means of parental income, education, and occupation. Although most of the more recent studies include information on the spatial variability in labor market conditions, none of the studies seems to fully explore the spatial dimensions of the student's decision process as well as the potential relevance of localized social interactions.

It is often assumed that characteristics of the regional surroundings of the parental household are the main source for variations in expected earnings and expected employability after schooling. Because some authors argue that it is quite unlikely that educational decisions are dominated by expectations related to the region where the student might possibly work after graduation (Hartog and Serrano, 2002), many studies introduce controls for spatial heterogeneity based on the regions where students live when making the decision to continue education or not. The spatial heterogeneity is generally related to labor market characteristics, although this seems to be an unnecessary restriction. Regional characteristics, such as the level of educational attainment, the intellectuality of the regional milieu, and the availability of local amenities may also be relevant (Sá et al., 2004). In order to control for such aspects, some studies include regional dummies, usually derived from a rather crude division of the country in large heterogeneous entities such as North, South, East, and West (see Giannelli and Monfardini, 2003, in a study for Italy; and Nguyen and Taylor, 2003, in a study for the US).

In most studies, individual students are the unit of analysis. However, individuals cannot be treated in isolation, and social interaction patterns should be accounted for (Manski, 2000; Brock and Durlauf, 2002). Although it is virtually impossible to identify one single social context that is most important for the student's choice behavior after leaving high school, it is likely that the interaction in a cross-sectional dataset of individual students can best be captured by assuming clustering among students attending the same high school. Students attending the same high school tend to be rather homogeneous in their socio-economic background, because they usually come from the same type of neighborhoods. They also share various features of their everyday life, because they spend a significant part of the day attending classes together, they are being taught by the same teachers, and they are prone to spending some of their leisure time together. We therefore follow Moulton (1990) in maintaining that it is reasonable to expect that individuals that share an observational characteristic like location (or high school) also share other unobservable characteristics, implying that disturbances are correlated.

We emphasize an additional spatial aspect in this paper, apart from accounting for spatial heterogeneity and localized social interaction as indicated above. Some previous studies have experimented including distance to higher education institutions among the explanatory variables in the analysis of transitions of high school leavers (see, for instance, Kjellström and Regnér, 1998). However, none of the studies has considered the distance impediment in terms of a system-wide accessibility measure that includes all higher education institutions, eventually even distinguishing between professional colleges and universities. The latter is not only potentially relevant in explaining the choice behavior of students, but it also provides important information for making informed policy decisions because, effectively, in most European countries the spatial distribution of higher education institutions is to a considerable extent determined by the national government (see Florax, 1992; Florax et al., 2004; Sá et al., 2004).

We address the above issues using individual data on choices of high school leavers with a diploma, and combine these data with information on high schools and regional characteristics, for the Netherlands. Our main hypothesis states that individuals who live in closer proximity to a specific type of higher education institution (i.e., a professional college or a university) are more likely to continue studying after high school, and they are more likely to choose that type of institution, even after controlling for spatial heterogeneity and social interaction, as indicated above. We investigate the behavior of Dutch high school leavers at the end of the last century (1998–2000) by means of a multinomial logit model distinguishing between university education, professional training, and no higher education, as the main alternatives.

This paper continues as follows. Section 2 provides background information on the Dutch educational system. A state of art overview of the literature on choice behavior of high school leavers is presented in the Sect. 3. Sections 4 and 5 cover data issues, the empirical model, and the estimation results. Section 6 concludes.

2. The Dutch educational system

Dutch students are admitted to secondary school after leaving primary education at an average age of 12, and schooling is mandatory until the age of 16. Students are essentially free to attend the high school of their choice. In practice, at the end of primary schooling, pupils receive a school report describing their level of attainment and potential, which is based on the results of an attainment test and the educational performance, interests and motivation of the child. This report is the basis for primary schools advising parents as to the type of secondary education that is most suitable for their child.

Secondary education comprises schools providing practical training (PRO), pre-vocational secondary education (VMBO), general secondary education (HAVO), and pre-university education (VWO).[1] PRO is a special form of secondary education aimed at training students to obtain direct access to low-skill jobs. VMBO is one step up; it comprises a four-year program providing the basis for further professional education. The HAVO track takes five years, and prepares students to proceed with higher education at post-secondary professional colleges. The longest track, VWO, takes six years and prepares students to go to university, although students with a VWO diploma do also have access to post-secondary professional colleges. In both HAVO and VWO, students have to choose one out of four program profiles: science and technology, science and health, economics and society, or culture and society. The different profiles include both a set of courses common to all profiles (for instance, Dutch) and a series of courses specific to the profile.

The post-secondary or tertiary step of the educational system comprises the higher education sector. The Dutch higher education system is a dual system, with 13 universities (WO) and 50 vocational/professional colleges (HBO), which are almost all entirely publicly funded.[2] Every year, the national government determines minimum requirements regarding the secondary school diplomas that allow students to apply for post-secondary study programs. Institutions can impose additional prerequisites with respect to the profile and/or high school courses included in the diploma. In general, all students with a secondary school diploma have access to university education, that is, for most study programs there are no supply constraints, although some exceptions apply.[3] The same is not entirely true for professional colleges, which tend to have a somewhat greater autonomy in defining their admission criteria. Typically, they fix a broader range of entrance requirements, in particular related to skills, talent, or fitness for a profession.

Students are required to pay admission fees, which are equal across institutions and generally not very high. Quality differences between educational institutions are considered negligible in The Netherlands. Regular full time students are eligible for student support provided by the national government, which is compatible with some part time jobs. All students are eligible for a basic scholarship for the nominal duration of the higher education program (4 or 5 years), the exact amount of which depends on whether the student lives with his or her parents. Depending on their parents' and their own income, students can also apply for additional funding, which is eventually supplied in the form of a supplementary grant or even a loan. Since 1990, all students receive a public transport pass, allowing free travel during workdays and discounted travel on weekends. Until the 1970s, a policy of geographical decentralization of the higher education system resulting in the establishment of new universities was implemented in The Netherlands. This was guided mainly by spatial equity reasons. As a result, the geographical accessibility of the university system is relatively high; there are about three universities per 100 by 100 km grid cell. The same goes for post-secondary professional colleges, of which the spatial distribution has traditionally been very even (see Florax et al., 2004).

The above characteristics of the Dutch higher education system, pointing to rather inexpensive, spatially balanced and easy access to higher education, makes it less likely that price and supply considerations play a major role in the choice behavior of students. In addition, given the high spatial density of institutions, one can wonder whether distance to the institutions is really an impediment

3. Choice behavior of high school leavers

There is an extensive literature on choice behavior of high school leavers. We present a concise overview here, concentrating on aspects that have been identified as relevant to the decision whether or not to continue (post-secondary) education.

Human capital theory looks at education as an investment good. The decision to continue education depends on the anticipation that future returns for a post-secondary degree, over and above those for a secondary degree, outweigh the additional costs of extended schooling (including income forgone). Apart from being an investment decision, the demand for education can also be a current consumption choice (Kodde and Ritzen, 1988; Duchesne and Nonnemann, 1998). Students may attend college simply because they like the courses or the student life-style. Theories considering schooling as a consumption activity assume the demand for higher education to vary positively with student income and negatively with both direct (tuition) and indirect (opportunity) costs. Kodde and Ritzen (1984) integrate consumption and investment motives in a unique model, according to which students choose the optimal level of education, and current and future consumption, subject to time and budget constraints. The solution for the maximization problem suggests that the individual's demand for education is a function of direct and indirect costs, income and wage differentials.

The direct cost of attending a higher education institution has received quite a lot of attention in empirical work. Direct costs include tuition, books and fees; expenditures for food and housing are not always considered because these exist in any case. The empirical literature shows that human capital investments are more likely when costs are lower (Bishop, 1977; Fuller et al., 1982). Studies analyzing the effect on participation of the presence of a college in the students' hometown find that the participation effect is larger for students who would otherwise stop schooling at low levels (Card, 1993). Financial support packages, covering at least partly the expenses of college education, are available in most higher education systems. The amount of financial aid, either in the form of grants or scholarships, generally has a positive effect on the probability of enrollment (Fuller et al., 1982; Catsiapis, 1987).

Household income is another important determinant of the decision to continue studying after the secondary education level. Most studies find that the higher the household income, the higher the demand for post-secondary education as well as the propensity to be in school after the secondary level (see, for instance, Savoca, 1990; Duchesne and Nonnemann, 1998; Checchi, 2000; Hartog and Serrano, 2002). Educational attainment of parents and/or their occupational status are sometimes used either to proxy this income effect, or to capture the independent positive influence it has on youngsters' decisions to attend higher education (e.g., Checchi, 2000; Hartog and Serrano, 2002; Nguyen and Taylor, 2003).

Average earning differentials between higher education graduates and high school graduates have been shown to be a good indicator of the relative labor market conditions. Empirical studies have found a positive effect of the wage differentials between college and non-college occupations in local labor markets on the student's likelihood to attend post-secondary education (see, e.g., Duchesne and Nonnemann, 1998; Hartog and Serrano, 2002). However, individuals have to assess their probability of becoming successful in specific fields and/or occupations as well. The expectation of future unemployment reduces the returns to education, and can therefore reduce the demand for higher education (Ordovensky, 1995; Riphahn, 2002). Current unemployment also plays a role in this decision process, with poor employment prospects retaining youngsters in school (Corman and Davidson, 1984; Savoca, 1990; Hartog and Serrano, 2002; Giannelli and Monfardini, 2003). Some recent studies also incorporate the effect of family, neighborhood and ethnicity on individual human capital decisions, probably because knowledge of the behavior of others reduces the risk and uncertainty involved in this type of decisions (Borjas, 1995). Finally, human capital theory also predicts that *ceteris paribus* myopic people are less likely to go to college than forward-looking people, and that most college students are young (Ehrenberg and Smith, 2000). The present-orientedness is quite difficult to test, but age has been included in most of empirical studies.

In addition to the consumption and human capital motive, participation in post-secondary education may also be related to higher education functioning as a screening or filtering device (see, e.g., Kodde and Ritzen, 1984). While the human capital theory suggests that education increases individual human capital, the screening theory asserts that there is a selection effect at work. Participation in higher education is restricted to the more capable students, which also happen to be more productive. This is subsequently useful information for future employers, and higher education hence operates as a filter. It is therefore quite relevant to take into account talents and track records of students, where better and/or more talented students are expected to have a higher demand for higher education. Many studies use test scores as a proxy for individual talents and performance. They show that students with higher scores are more likely to attend post-secondary education (Fuller et al., 1982; Venti and Wise, 1983; Catsiapis, 1987; Maani, 2000), in particular academic programs (Ordovensky, 1995; Nguyen and Taylor, 2003).

Previous empirical studies also find a series of other individual, family and school characteristics to be relevant. Gender seems to play a role in participation, but the results are not consistent across studies (Kodde, 1986; Kodde and Ritzen, 1988; Savoca, 1990; Ordovensky, 1995; Checchi, 2000). Race differentials are an important determinant of differences in college enrollment (Black and Sufi, 2002). According to most of the studies, black youth are more likely to continue schooling than whites (Venti and Wise, 1983; Catsiapis, 1987; Rice, 1999; Nguyen and Taylor, 2003). Parental nationality and family structure have been identified as relevant factors as well (Nguyen and Taylor, 2003).

The type of secondary school that students attend may determine how likely the student is to enroll in higher education (Catsiapis, 1987; Kodde and Ritzen, 1988; Checchi, 2000; Nguyen and Taylor, 2003). The direction of this effect varies, however, between countries and with the structure of the educational system. Effects related to the school's location are also taken into account in some studies. The social status of the neighborhood where the high school is located has a positive effect on youngsters' attendance of higher education institutions (Bishop, 1977). The educational track, the academic quality of the institution, and plans of peers appear to have a positive effect as well (see for instance, Fuller et al., 1982; Savoca, 1990; Ordovensky, 1995; Maani, 2000). Finally, as far as spatial effects go, the level of urbanization has been shown to play a role in determining choice behavior (Riphahn, 2002; Giannelli and Monfardini, 2003; Nguyen and Taylor, 2003). Most studies also find a negative distance effect (see for instance, Fuller et al., 1982; Ordovensky's, 1995; Sá et al., 2004), although there are exceptions as well (for instance, Kjellström and Regnér, 1998).

The above literature review shows that there is a vast series of potential determinants of the choice behavior of high school students with respect to the decision to continue education (either at a professional college or a university) or choose another option, including entering the labor market. Typically, the determinants are personal characteristics (including family background), school characteristics, and spatial characteristics. The overview also shows that it is important to take into account that decisions are not made in isolation, but rather within a network of social interactions. Finally, the overview shows that spatial effects and the impediments of distance should not be ignored. In the next section, we discuss how we include these aspects.

4. Empirical framework

4.1 General model

We model the choice behavior of high school graduates on the basis of a utility maximization framework in a multinomial choice model. Let *i* represent the student, *j* stand for high school, and k indicate the geographical location of the student at the moment of graduation, and each student choose between three different alternatives a, either: no higher education, go to a professional college, or enter a university program (a = 1, 2, or 3, respectively). The utility associated with alternative a is then given by:

$$U_{ijk}^{(a)} = V_{ijk}^{(a)} + \varepsilon_{ijk}^{(a)}, \tag{1}$$

where $V_{ijk}^{(a)}$ is a linear predictor, and $\varepsilon_{ijk}^{(a)}$ a random term. Alternative f is selected over any other alternative g if $U_{ijk}^{(f)} > U_{ijk}^{(g)}$, for all g, or, equivalently, $U_{ijk}^{(f)} - U_{ijk}^{(g)}$ = $V_{ijk}^{(f)} - V_{ijk}^{(g)} + \left(\varepsilon_{ijk}^{(f)} - \varepsilon_{ijk}^{(g)}\right) > 0$. If the error term $\varepsilon_{ijk}^{(a)}$ has a Type I extreme value distribution (Gumbel), the differences $\left(\varepsilon_{ijk}^{(f)} - \varepsilon_{ijk}^{(g)}\right)$ have a logistic distribution, and it follows that the multinomial probability of response category f equals:

$$\pi_{ijk}^{(f)} = \frac{\exp\left(V_{ijk}^{(f)}\right)}{\sum_{a=1}^{A} \exp\left(V_{ijk}^{(a)}\right)}, \tag{2}$$

where $\pi_{ijk}^{(f)}$ is the probability that f is chosen, and $\sum_{a=1}^{A} \exp\left(V_{ijk}^{(a)}\right) = 1$. In order to ensure identification of the model, we set alternative $a = 1$ (no higher education) as the base category.

4.2 Data and variables

The variables in V_{ijk} refer to personal characteristics of the individual indexed by i, characteristics of the high school that he or she attends indexed by j, at the spatial location of the moment of graduation indexed by k, the latter including accessibility to professional colleges or universities.

► Tables 1 and 2 about here ◄

Descriptive statistics of the data according to the three dimensions of variation (personal, high school, space) are given in Table 1, and the distribution across the different choice categories is given in Table 2.

4.2.1 Personal characteristics

The data on student choices and other personal characteristics come from the RUBS survey (*Registratie Uitstroom en Bestemming van Schoolverlaters*) conducted by ROA (*Researchcentrum van Onderwijs en Arbeidsmarkt*) among students graduating from a pre-university high school (VWO; see Sect. 2). The students are randomly selected in a stratified sampling process, in which high schools are sampled first and students in the subsequent second stage. We use survey data on 1998, 1999 and 2000 graduates, who have responded to a questionnaire 18 months after graduation. The resulting subsample contains 3263 observations.[4] The dataset contains the name and location of the high school, information about the respondent's main activity at the time of the survey (being a student, working, or out of the labor force), and if applicable, the type of schooling. This information is used to create the choice variable (1 for no higher education, 2 for professional training, and 3 for university education), where the no higher education option is a mix of activities such as working, unemployment, out of the labor force, and non-tertiary education.

In the line with previous studies, we derive information on personal characteristics from the sample, including gender, citizenship, parental citizenship, and age. We also obtain information on school performance by means of the mean grade point average (GPA). Finally, because high school programs are organized in different 'streams' from which students may choose, we distinguish four profiles (science and technology, science and health, culture and society, and economics and society) by means of dummy variables.

We have data referring to three different cohorts of graduates, which we pool for estimation purposes. Since the distributions of variables tend to change over time, the identical distribution assumption may be not valid, although the independence assumption still holds. We therefore include cohort dummies in the econometric model to capture aggregate changes over time (see Wooldridge, 2002).

Table 1 shows that the graduates are evenly distributed across the choice categories as far as gender, citizenship, age, and cohort are concerned. The grade point average is slightly higher for those who attend a professional college, and highest for those going to the university. In terms of profile, graduates with a science profile are most likely to go on studying at the university level, whereas graduates with an economics profile are prone to directly enter the labor market.

Table 2 shows that approximately 30% of the graduates choose a professional college, 65% continues education at a university, and 6% goes elsewhere, mainly directly entering the labor market. The choice behavior reflected in the sample information corresponds very well to the population. For 1999, for instance, the ministry reports that 26.2% of the VWO graduates chose professional training, 66.5% university education, and 7.2% went elsewhere (OCW, 2003, p. 49).[5] In terms of gender, women are slightly overrepresented in the choice categories indicating no education, and professional college. Remarkably, non-Dutch students and/or those that have non-Dutch parents are both more inclined to choose either not to continue their education, or to go to university.

4.2.2 High school characteristics

Most countries show considerable differences in performance between high schools. This variation may be attributable to the background of students and schools, human and financial resources available to schools, curricular differences, selection policies, and the organization of teaching (OECD, 2003). We include a limited number of high school characteristics in our analysis, and obtain these characteristics from yearly quality reports of each high school in the Netherlands, as conveyed in the evaluation of high schools by educational assessment authorities (*Inspectie Onderwijs*).

High schools in the Netherlands vary according to denomination. We distinguish public high schools, from private (non-religious) high schools, and private high schools with a religious denomination. We also include information on the size of the high school in terms of the total number of students, ranging from 426 to 3,020.

Tables 1 and 2 do not show large differences between the choice categories according to high school characteristics, except maybe for school size. Specifically, in bigger schools, graduates are more likely to not continue their education, and in smaller schools, graduates are slightly more likely to go to university. There is a slight indication that graduates from private religious schools are more prone to choose a professional college.

4.2.3 Spatial characteristics

The dataset does not contain information on family income and parental education. We therefore use areal data at the municipality level to capture these effects. The effect of the student's socio-economic background is included by using income per capita of the municipality where the high school is located. The impact of cultural background and amenities is taken into account by including the level of urbanization of the municipality in which the high school is located, which is operationalized as population density. Both variables are obtained from the national statistics agency, CBS (2003). Table 1 shows that there are no significant differences in per capita income across the different choice categories. The respective choice categories no higher education, professional college, and university are inversely related to population density.

If individuals, in a human capital like manner, regard further education as an investment, their choices will depend on (current and future) labor market conditions. Due to lacking data, we cannot explicitly include local labor market characteristics in the analysis. Moreover, it is likely that other unobserved spatial characteristics play a role in the choice behavior of graduates (for instance, regional production structure differences, or cultural differences), and/or that the choices of graduates are spatially clustered. In order to avoid misspecification problems, we include dummies for the Dutch provinces as control variables.[6] In doing so, we account for spatial heterogeneity, which is altogether different from spatial dependence (or autocorrelation) that may be relevant as well. One should note, however, that spatial heterogeneity and spatial dependence are generally difficult to disentangle in an empirical sense (Anselin, 2001; Florax and Nijkamp, 2004), and a corrective device for one of the misspecifications is likely to affect the seriousness of the other misspecification as well. Given the complexity of handling spatial dependence in a multinomial logit framework (see Fleming, 2004), we deal with spatial effects by allowing for spatial heterogeneity through spatial fixed effects.

Finally, we incorporate two accessibility measures in our model, referring to spatial or geographical accessibility to professional colleges and universities, respectively. One should note, that the accessibility varies not only over space – which is obvious – but also over groups of individuals, because the eligibility to enter specific college and university programs depends on the high school profile (science and technology, science and health, culture and society, or economics and society) the graduate adopts. Moreover, since we do not have exact georeferenced information as to where the graduate lives, we use the distance between the graduate's high school and the respective colleges and universities. For ease of notation, we only use the subscript k, referring to space, instead of a more complex set of subscripts. Accessibility to universities is then defined as:

$$a(u)_k = \sum_{l=1}^{L_{i\in p}} \frac{1}{d_{jl}}, \tag{3}$$

where $L_{i\in p}$ is the total number of universities offering study programs for which student i who followed profile p in high school is eligible, and d_{jl} is the distance between the municipalities where the high school and the university are located, respectively. By analogy, we define the accessibility measure for professional colleges, $a(c)_k$. Accessibility measures are strictly positive,[7] and we assume that the higher the accessibility the greater the chance of choosing one of the educational alternatives. Following utility theory for these kinds of models, the accessibility variables are included in logarithmic form (see, for instance, Rietveld and Bruinsma, 1998; Ortúzar and Willumsen, 2001).[8]

Table 1 shows that the geographical accessibility to professional colleges is substantially greater than to universities (0.97 vs 0.26), which is obvious given the total number of institutions of both types (circa 50 vs 13).

4.3 Utility function and econometric aspects

The general formulation of the utility each individual takes from each choice depends on individual, high school related, and spatial aspects, in the following way:

$$V_{ijk}^{(a)} = \alpha^{(a)} + \beta^{(a)\prime} x_i + \delta^{(a)\prime} y_j + \gamma^{(a)\prime} z_k + \theta_1^{(a)} \log\left(a(u)_k\right) + \theta_2^{(a)} \log\left(a(c)_k\right), \tag{4}$$

where a = 1 (no higher education), 2 (professional college), or 3 (university), x_i is a vector containing variables with personal characteristics, y_j contains high school characteristics, z_k spatial characteristics, and $a(u)_k$ and $a(c)_k$ refer to university and college accessibility, respectively. For reasons of identification, the coefficients referring to choice 1 are all set to zero.

The utility associated with the choice of professional college education does, however, not depend on how accessible university alternatives are, and *mutatis mutandis* the same holds for the university alternative. This implies that we set $\theta_1^{(2)} = 0$ and $\theta_2^{(3)} = 0$, in order to obtain:

$$V_{ijk}^{(2)} = \alpha^{(2)} + \beta^{(2)'} x_i + \delta^{(2)'} y_j + \gamma^{(2)'} z_k + \theta_2^{(2)} \log(a(c)_k), \tag{5}$$

and

$$V_{ijk}^{(3)} = \alpha^{(3)} + \beta^{(3)'} x_i + \delta^{(3)'} y_j + \gamma^{(3)'} z_k + \theta_1^{(3)} \log(a(u)_k), \tag{6}$$

for the utilities associated with choosing professional colleges and universities, respectively.

Before proceeding with the estimation of the above utility functions in a multinomial logit setting, we motivate some salient econometric issues at stake. We have identified the potential of correlation among the individual observations because of network effects and/or spatial clustering. The former may be caused by social interaction in localized networks, and the latter by unobserved spatial characteristics such as regional labor market conditions. Lacking data prohibits the explicit incorporation of these phenomena in the model specification, and we therefore resort to accounting for the correlation by choosing an appropriate estimator. A straightforward way of accomplishing this is to use the Huber-White ('sandwich') estimator (see Wooldridge, 2002, Section 13.8.2, for details). This is, however, not possible for spatial clustering, because a disjoint classification of spatially clustered individuals is at odds with the mere concept of spatial clustering.[9] We therefore use the Huber-White type of clustering to model localized social interactions. Specifically, we expect students attending the same high school to be more similar in their characteristics than individuals randomly chosen from the population. One can of course argue that social interaction and networks extend beyond the school's boundaries, for instance, to the neighborhood of residence. Since students attending the same high school tend to come from the same type of neighborhoods and socio-economic contexts, we choose to define social interaction, and hence correlation among choices, by means of the high school attended by students.

As mentioned above, modeling spatial clustering (or dependence) in a multinomial logit model is rather cumbersome (see Fleming, 2004), and we therefore incorporate spatial effects by focusing on spatial heterogeneity through the inclusion of fixed effects for provinces. The fixed effects are intended to capture, among other things, regional labor market conditions. The fact that regional labor market conditions are likely to be correlated to per capita income and population density makes a fixed effects specification preferable over a random effects specification, because the correlation with the exogenous variables would cause the random effects estimator to be biased.

In the next section, we present the estimation results for a multinomial logit model, with fixed spatial effects and Huber-White adjusted standard errors based on clustering of individuals attending the same high school, produced with the STATA 8.0 software.

5. Estimation results

The estimation results are recorded in Table 3. The model correctly predicts about 67% of the choices of graduates. The coefficients, however, are difficult to interpret, as they refer to the effect of each variable on the log-odds ratio between the choice (professional college, or university) and the no higher education option. In order to avoid these difficulties, we compute marginal effects of each variable on each possible outcome (see Table 4). The reference case chosen in the computation of the marginal effects is a female Dutch student, with at least one Dutch parent, who chose the science and technology profile and graduated in 1998 from a private school with a religious denomination, located in Zuid-Holland. All continuous variables are set to their sample means.

► Tables 3 and 4 about here ◄

Tables 3 and 4 show that male students are more likely to go to university, and women to attend a professional college. The results also show that a student not being Dutch and/or having non-Dutch parents contributes to the odds of choosing the university alternative. The age of the student is negatively correlated with the university option, and positively with the professional college option, whereas the effect on choosing the no higher education option is not significantly different from zero.

The results for the different profiles and the time trend (i.e., graduation cohorts) are particularly hard to interpret, because they should be compared to the omitted categories (science and health profile, and 1998 graduates, respectively). The results seem to indicate that, as compared to the science and health profile, graduates with other profiles are more likely to choose the professional college option. In addition, graduates with an economics and society profile are also more inclined to choose not to continue with higher education. The results for the time trend seem to indicate that over time, graduates have a tendency to turn away from academic training as compared to professional training or no continued training.

In accordance with previous studies, the student's high school performance and talents, as measured by the grade point average, has unequivocally the biggest marginal effect on the odds of choosing the university option. Although universities have so far not been allowed to pre-select students, there is a rather strong mechanism of self-selection at work.

With respect to high school characteristics, there is a slight tendency for graduates from public as well as private high schools (although in the latter case, the results are statistically not significant), as compared to graduates from private schools with a religious denomination, to choose the no higher education and the university education option as compared to professional colleges. It is unclear whether this is partly an artefact of the proportion of professional colleges with a religious denomination being higher than the proportion of universities with a religious base. The size of high schools has no discernable effect.

The spatial characteristics per capita income and population density (or level of urbanization for that matter) are not significantly different from zero. This may, however, be partly related to the relatively high level of spatial aggregation that we use given restricted data availability, and to correlation with the fixed spatial effects. The direction of the estimated effects for income and population density are, however, as expected. In municipalities with higher per capita incomes, graduates are more prone to go to university, and this effect is relatively large in magnitude. There is a very small effect (not significantly from zero either) of graduates going to school in municipalities with a high population density being more inclined to go to a professional college.

With respect to the spatial fixed effects for the different provinces, one should again note that the marginal effects should be compared to the omitted category Zuid-Holland, which is one of the most dense and urbanized provinces in the Netherlands. Given the signs and significance of the effects, it is actually likely that the dummy variables do pick up regional labor market differences as well as differences in other regional characteristics. Specifically, the marginal effects indicate that graduates living in rural areas (i.e., all provinces outside the highly urbanized Randstad, which is located in the provinces of Noord-Holland, Zuid-Holland, and Utrecht), in comparison to Zuid-Holland, have a tendency to prefer the education to the non-education option. Moreover, in all cases but two (Limburg, which has a very popular 'regional' university; and Flevoland, which is a polder very close to Amsterdam and Utrecht, which harbor big universities) they prefer to go to a professional college. Hence, there is a rather pronounced dichotomy between the Randstad area and the rest of the Netherlands.[10]

We end this discussion of the estimation results by looking more closely at the results related to geographical accessibility or distance deterrence. The coefficients of the accessibility variables show that geographical accessibility plays a significant role in determining the choices of youngsters in their transition from high school to post-secondary education or dropout of the educational system. Accessibility to professional colleges exerts a positive impact on decisions to continue with a professional education, while accessibility to university institutions has a positive influence on going to a university. A one-percent increase in any of the accessibility variables hardly affects the probability of the non-higher education option (the probabilities decrease by only 0.0067 and 0.0089, respectively). If the accessibility to professional colleges increases by one percent, the probability of choosing that type of institution increases by 0.11, at the same time lowering the probability of choosing the university option by approximately the same amount (0.10). Similarly, although somewhat smaller in magnitude, a one-percent increase in the spatial accessibility of universities increases the probability of choosing academic education by 0.06, with a concurrent decreasing effect of the choice for a professional college. The difference in magnitude of the effects between the two types of higher education illustrates that participation in professional training is more sensitive to changes in accessibility than university participation. It is important to note, however, that the number of universities is substantially smaller than the number of professional colleges (13 vs about 50). Hence, the number of new professional colleges required to bring about a 1% increase in accessibility is substantially higher than the number of new universities needed to accomplish a similar increase in university accessibility.

The effects of changes in accessibility are further illustrated by a series of simple simulations, the results of which are presented in Figure 1. The estimated average probabilities referring to the actually existing situation are 5.3% for the no higher education choice, and 29.1% and 65.6% for the choices professional college and university, respectively (see Table 2). This is the option highlighted in Figure 1 by means of the dashed vertical line.

► Figure 1 about here ◄

The simulations in Figure 1 cover various situations. First, we give the reference case, with the actual (act) accessibility levels for both professional colleges and universities (the vertical dashed line). Second, we compute the choice probabilities by fixing the accessibility to the minimum (min) or the maximum (max) level observed in the sample. And finally, we re-compute the accessibility level assuming that either one of the universities is closed down, or a professional college in one of the university towns is closed down. In the closedown case the choice probabilities shown in Figure 1 are the average of the different closedowns considered. The options in Figure 1 are grouped in ascending order of the probability of choosing to continue with a university education.

The figure clearly shows that changes in the accessibility of the higher education system have virtually no effect on the total number of high school graduates that decides to stay within or drop out of the higher education system. Hence, changes in the spatial accessibility of the higher education system have hardly any impact on the participation of youngsters in higher education as a whole. Changes in the accessibility of either compartment of the higher education system have a clear effect, however. The scenario where the accessibility of professional colleges is fixed at the sample maximum increases the likelihood of their choice, at the detriment of the university choice. *Mutatis mutandis*, similar effects hold for universities and for the scenario where the accessibility is fixed at the sample minimum.

Finally, the figure shows that the effect of closing down either one university or one professional college (in a university town) has only a very small effect on national participation figures. At the local or regional level, the effect is of course notable, especially when the closure takes place in regions that are strongly oriented towards a particular institution. Consider, as an illustration, high school leavers from the city of Groningen located in the periphery of the country, rather far away from other university cities. The share of high school leavers going to the local university is 57.4%. In addition, 10.1% (=67.5%-57.4%) go to other universities further away. The remaining students go to professional colleges (29.63%) or start working (3.70%). Our estimation results imply that when the university of Groningen would be closed, the share of school leavers in the city that enters university decreases by 11.1% (that is, it goes from 67.5% to 56.4%). This means that of the 57.4% that is directly affected by the closure of the university, 46.3% decide to go to another university, 10.2% decide to switch to HBO and 0.9% start working. These figures indicate that the main effect of closing universities in a city is that demand for higher education shifts either to universities elsewhere or to professional colleges. Groningen is a rather extreme case because it is far away from other university cities. Hence the effects of closure of a university on demand for university education will be considerably smaller for other locations.

6. Conclusions

Previous studies have documented that a wide range of personal, high school, and spatial factors determine the decisions of school leavers to continue their education or to drop out of the higher educational system. However, there has only been limited attention for the potential relevance of localized social interactions and for the impact of space. The latter concerns both heterogeneity of the observed phenomenon over space as well as the potential distance deterrence effect that can be captured by accounting for spatial or geographical accessibility of the higher education system. We address these important issues in a case study of high school graduates in the Netherlands, during the period 1998–2000. We use a multinomial logit model to investigate the choice behavior of high school graduates 18 months after graduation, assuming that the school leavers have three options: university education, professional training, or no higher education. Localized social interaction is taken into account by allowing for observations of high school graduates attending the same high school to be correlated. Spatial effects are interpreted as spatial heterogeneity, and taken into account by including fixed effects for areal units. The distance deterrence effect is incorporated through the inclusion of geographical accessibility indices for professional colleges and universities, respectively. We also try to mitigate omitted variable problems by including variables for both personal as well as high school characteristics.

The empirical results confirm that past high school performance and talent of the high school graduate are strongly related to students' likelihood to go on to higher education. Another eye-catching result is that non-citizens and students with non-Dutch parents are more likely to choose to go on to university. Most importantly, we show that the choice behavior of graduates has salient spatial dimensions.

Although not significantly different from zero, it is clear that in municipalities with higher per capita incomes, high school graduates are more prone to go to university, and this effect is relatively large in magnitude. Concurrently, population density has a relatively small effect on the likelihood of high school graduates going to a professional college. There is also a distinct dichotomy between the highly urbanized Randstad area and the rest of the Netherlands: graduates living in rural areas have a tendency to prefer the education to the non-education option, and they prefer to go to a professional college. The most outstanding spatial result is, however, that the geographical accessibility of the higher education system significantly contributes to high school graduates choosing to continue education. This effect is strongest for professional colleges: a 1% increase in the accessibility of professional colleges increases the odds of high school graduates choosing this option by 0.11. The corresponding effect for universities is about half the size (0.06).

Our research can obviously be extended in various ways. It would be particularly useful to be able to incorporate information on living arrangements of students (see, for instance, Martinez-Granado and Ruiz-Castillo, 2002), and to focus on the impact of supply constraints in the professional education tier of the higher education sector. Future research geared towards investigating the choice behavior of prospective students based on precise georeferenced individual data can contribute to using sophisticated spatial econometric techniques.

Endnotes

1 The abbreviations are derived from the Dutch as follows: schools for practical training (PRO, *Praktijkonderwijs*), pre-vocational secondary education (VMBO, *Voorbereidend Middelbaar Beroepsonderwijs*), general secondary education (HAVO, *Hoger Algemeen Voorbereidend Onderwijs*), and pre-university education (VWO, *Voorbereidend Wetenschappelijk Onderwijs*).

2 Universities are referred to with the abbreviation WO (*Wetenschappelijk Onderwijs*), and vocational or professional colleges are labeled HBO (*Hoger Beroepsonderwijs*). Over the last two decades, mergers have resulted in a sizeable reduction of the number of HBO institutions, going from 350 in mid-1980s to 56 in 2000, and subsequently to 50 in 2002 (OCW, 2003, pp. 74, 81).

3 For a limited number of profession-oriented programs, such as medicine, dentistry, veterinary science, and information science, the national government fixes the number of students based on prospective demand in the labor market (*numerus clausus*).

4 The costs of the RUBS survey are partly born by the high schools, whose decision to participate in the survey is voluntary. The survey covers different schooling types, but we restrict the sample to graduates from VWO because those are the only students for which the three choices (i.e., no higher education, professional college, or university) are available. We use the 1999, 2000, and 2001 surveys, referring to the school year 1997/98, 1998/99, and 1999/2000, and include only those students that obtain a diploma and who supply information on all relevant variables. See Potma and Kolk (2000), Potma (2002), and Huijgen (2002), for details on the surveys.

5 These figures are not perfectly comparable due to slightly different definitions and the moment at which the information is obtained (see OCW, 2003).

6 We have experimented with different levels of spatial aggregation (for instance, the so-called NUTS I and II levels), but found that a low level of aggregation, with many fixed effects as a result, explains away most of the variation. We therefore include 10 dummy variables for the 12 Dutch provinces,

because one of the provinces (Drenthe) is not represented in the dataset, and the provinces of Zeeland and Noord-Brabant are pooled because of the low number of observations in the 'no higher education' category.

7 In order to avoid scale problems we define the intrazonal distance, which is relevant when a high school and a college or university location coincide in the same municipality, as:

$$d_i = (\pi - 1)/\pi \cdot \sqrt{s_i / \pi} \ ,$$

where s_i is the area of region i measured in square meters (see Rietveld and Bruinsma, 1998). The formula assumes that regions are circular, and all zones are equally intensively used. Although various alternative intrazonal measures are possible as well (see Sá et al., 2004), they do not have any serious bearing upon the results.

8 Rietveld and Bruinsma (1998, pp. 36–37) describe this type of accessibility measures in the context of the use of infrastructure services. The accessibility of a facility in a transport network is the expected value of the maximum utility of visiting that facility, which is assumed to depend on the mass of the facility, the travel costs of a trip to that facility, and a stochastic term. If the stochastic term is Weibull distributed, stochastic utility theory presumes accessibility measures that are typically of the form A = log Σ_j exp(utility's deterministic part), where A refers to accessibility, and j to destinations.

9 The Huber-White estimator requires the identification of observations that belong to clusters or groups of correlated observations. This is perfectly feasible if one assumes network effects among individuals belonging to the same group or network (see the sequel of the main text). However, the nature of spatial dependence makes that all observations, regardless whether the observations refer to an individual or to an areal unit, typically belong to the same group. This can be seen as follows. In the spatial econometrics literature, spatial correlation is often modeled using contiguity or distance to determine spatial interaction. If, for instance, correlation is suspected among areal units that are contiguous, and unit *a* is correlated to unit *b*, and unit *b* to unit *c*, then unit *a* and *c* end up belonging to the same group of correlated observations regardless whether they are contiguous or not, simply because they have a mutual link to unit *b*.

10 This is consistent with earlier findings on the basis of a gravity model using aggregate areal data (see Sá et al., 2004).

References

Anselin L (2001) Spatial Econometrics. In: Baltagi B (ed) Companion to Theoretical Econometrics. Blackwell, Oxford, 310–330

Bishop J (1977) The Effect of Public Policies on the Demand for Higher Education. *Journal of Human Resources* 12(3):285–307

Black SE, Sufi A (2002) Who Goes to College? Differential Enrollment by Race and Family Background. Working Paper 9310, National Bureau of Economic Research

Borjas GJ (1995) Ethnicity, Neighborhoods, and Human Capital. *American Economic Review* 85(3):365–390

Brock WA, Durlauf SN (2002) A Multinomial-Choice Model of Neighborhood Effects. *American Economic Review Papers and Proceedings* 92(2):298–303

Card D (1993) Using Geographic Variation in College Proximity to Estimate Returns to Schooling. Working Paper 317, Industrial Relations Section, Princeton University

Catsiapis G (1987) A Model of Educational Investment Decisions. *Review of Economics and Statistics* 69(1):33–41

CBS, Centraal Bureau voor de Statistiek (2003) StatLine, Statistics Netherlands. http://statline.cbs.nl

Checchi D (2000) University Education in Italy. *International Journal of Manpower* 21(3–4):177–205

Corman H, Davidson PK (1984) Economic Aspects of Post-Secondary Schooling Decisions. *Economics of Education Review* 3(2):131–139

Duchesne I, Nonnemann W (1998) The Demand for Higher Education in Belgium. *Economics of Education Review* 17(2):211–218

Ehrenberg RG, Smith RS (2000) *Modern Labor Economics: Theory and Public Policy*. 7th edition, Addison-Wesley, Massachusetts

Fleming MM (2004) Techniques for Estimating Spatially Dependent Discrete Choice Models. In: Anselin L, Florax RJGM, Rey SJ (eds) *Advances in Spatial Econometrics: Methodology, Tools and Applications*. Springer-Verlag, Heidelberg, 145–168.

Florax RJGM (1992) *The University: A Regional Booster? Economic Impacts of Academic Knowledge Infrastructure*. Ashgate, Aldershot

Florax RJGM, Nijkamp P (2004, forthcoming) Misspecification in Linear Spatial Regression Models. In: Kempf-Leonard K (ed) *Encyclopedia of Social Measurement*. Academic Press, San Diego

Florax RJGM, Hall P, Titheridge H, Wikhall M (2004, forthcoming) A Comparative Analysis of the Geography of Student Recruitment and Labor Market Entry. In: Törnqvist G and Sörlin S (eds) *The Wealth of Knowledge: Universities and the New Economy*. MIT Press, Cambridge

Fuller WC, Manski CF, Wise DA (1982) New Evidence on the Economic Determinants of Post-Secondary Schooling Choices. *Journal of Human Resources* 17(4):477–498

Giannelli GC, Monfardini C (2003) Joint Decisions on Household Membership and Human Capital Accumulation of Youths. The Role of Expected Earnings and Local Markets. *Journal of Population Economics* 16(2):265–285

Hartog J, Serrano LD (2002) Earnings Risk and Demand for Higher Education. Discussion Paper 122/3, Tinbergen Institute, Amsterdam

Huijgen T (2002) Methodiek schoolverlatersinformatiesysteem 2001. ROA–W–2002/3, Researchcentrum voor Onderwijs en Arbeidsmarkt, University of Maastricht, Maastricht

Kjellström C, Regnér H (1998). Does Distance to a University Affect Enrolment Decisions? Evidence from Data on Three Cohorts of Swedes. Working Paper 8/98, Institute for Social Research, Stockholm University, Stockholm

Kodde DA (1986) Uncertainty and the Demand for Education. *Review of Economics and Statistics* 68(3):460–467

Kodde DA, Ritzen JMM (1984) Integrating Consumption and Investment Motives in a Neoclassical Model of Demand for Education. *Kyklos* 37(4):598–608

Kodde DA, Ritzen JMM (1988) Direct and Indirect Effects of Parental Education Level on the Demand for Higher Education. *Journal of Human Resources* 23(3):356–371

Kohn MG, Manski CF, Mundel DS (1976) An Empirical Investigation of Factors which Influence College-Going Behavior. *Annals of Economic and Social Measurement* 5(4):391–419

Maani SA (2000) School Leaving, Labor Supply and Tertiary Education Choices of Young Adults: An Economic Analysis Utilizing the 1977–1995 Christchurch Health and Development Surveys. Working Paper 00/3, New Zealand Treasury

Manski CF (2000) Economic Analysis of Social Interactions. *Journal of Economic Perspectives* 14(3):115–136

Martinez-Granado M, Ruiz-Castillo J (2002) The Decisions of Spanish Youth: A Cross-Section Study. *Journal of Population Economics* 15(2):305–330

Moulton BR (1990) An Illustration of a Pitfall in Estimating the Effects of Aggregate Variables on Micro Units. *Review of Economics and Statistics* 72(2):334–338

Nguyen AN, Taylor J (2003) Post-High School Choices: New Evidence from a Multinomial Logit Model. *Journal of Population Economics* 16(2):287–306

OCW, Ministerie van Onderwijs, Cultuur en Wetenschappen (2003) Facts and Figures 2003. http://www.minocw.nl/english/figures2003/pdf/figures2003.pdf

OECD (2003) Education at a Glance 2003. OECD Indicators. http://www1.oecd.org/publications/e-book/9603061E.pdf

Ortúzar JD, Willumsen LG (2001). *Modelling Transport*. Third Edition, Willey, Sussex

Ordovensky JF (1995) Effects of Institutional Attributes on Enrolment Choice: Implications for Post-Secondary Vocational Education. *Economics of Education Review* 14(4):335–350

Potma L (2002) Methodiek schoolverlatersinformatiesysteem 2000. ROA-W-2002/2, Researchcentrum voor Onderwijs en Arbeidsmarkt, University of Maastricht, Maastricht

Potma L, Kolk P (2000) Methodiek schoolverlatersinformatiesysteem 1999. ROA-W-2000/9, Researchcentrum voor Onderwijs en Arbeidsmarkt, University of Maastricht, Maastricht

Rice P (1999) The Impact of Local Labor Markets on Investment in Further Education: Evidence from the England and Wales Youth Cohort Studies. *Journal of Population Economics* 12(2):287–312

Rietveld P, Bruinsma F (1998) *Is Transport Infrastructure Effective? Transport Infrastructure and Accessibility: Impacts on the Space Economy*. Springer-Verlag, Heidelberg

Riphahn RT (2002) Residential Location and Youth Unemployment: The Economic Geography of School-to-Work Transitions. *Journal of Population Economics* 15(1):115–135

Sá C, Florax RJGM, Rietveld P (2004) Determinants of the Regional Demand for Higher Education in The Netherlands: A Gravity Model Approach. *Regional Studies* 38(4):373–390

Savoca E (1990) Another Look at the Demand for Higher Education: Measuring the Price Sensitivity of the Decision to Apply to College. *Economics of Education Review* 9(2):123–134

Venti SF, Wise DA (1983) Individual Attributes and Self-Selection of Higher Education: College Attendance versus College Completion. *Journal of Public Economics* 21(1):1–32

Wooldridge JM (2002) *Econometric Analysis of Cross Section and Panel Data*. MIT Press, Massachusetts

Table 1. Descriptive statistics by choice and personal, high school, and spatial characteristics, respectively (means, with standard deviations in parentheses for continuous variables)

Variables \ Choice	No education	College	University	Total
Personal characteristics				
Male	0.3851	0.3368	0.4474	0.4119
Non-Dutch	0.0460	0.0200	0.0453	0.0380
Parents non-Dutch	0.0690	0.0316	0.0790	0.0647
Age	19.4023	19.4421	19.2941	19.3429
	(0.7126)	(0.7085)	(0.6581)	(0.6793)
Grade Point Average (GPA)	6.5067	6.5531	6.9233	6.7933
	(0.5789)	(0.4843)	(0.6568)	(0.6333)
Science & Technology profile	0.2701	0.2379	0.4535	0.3809
Science & Health profile	0.1322	0.1789	0.1388	0.1502
Culture & Society profile	0.1494	0.1853	0.1267	0.1450
Economics & Society profile	0.4483	0.3979	0.2810	0.3239
1998 Graduate	0.3736	0.4526	0.4324	0.4352
1999 Graduate	0.2874	0.2968	0.2768	0.2832
2000 Graduate	0.3391	0.2505	0.2908	0.2816
High school characteristics				
Public school	0.2701	0.1895	0.2445	0.2298
Private school	0.0862	0.0684	0.0944	0.0864
Private religious school	0.6437	0.7421	0.6611	0.6837
School size	1406.8450	1396.0270	1304.3450	1336.5030
	(676.7423)	(633.2048)	(586.8493)	(607.1513)
Spatial characteristics				
Income per capita	9.6879	9.6343	9.6550	9.6508
	(0.6762)	(0.6184)	(0.6737)	(0.6582)
Population density	2444.8620	2183.7280	2247.3660	2239.3700
	(1089.7470)	(1105.4400)	(1108.9640)	(1108.0300)
College accessibility	1.0295	0.9677	0.9724	0.9741
	(0.2944)	(0.2927)	(0.2992)	(0.2973)
University accessibility	0.2899	0.2580	0.2597	0.2608
	(0.1455)	(0.1402)	(0.1250)	(0.1309)
Groningen	0.0632	0.0747	0.0827	0.0794
Friesland	0.0172	0.0116	0.0131	0.0128
Overijssel	0.0575	0.0905	0.0519	0.0634
Gelderland	0.0057	0.0074	0.0089	0.0083
Utrecht	0.0287	0.0316	0.0243	0.0267
Noord-Holland	0.1724	0.1589	0.1725	0.1686
Zuid-Holland	0.5805	0.4642	0.4525	0.4628
Zeeland, N-Brabant	0.0287	0.1074	0.0935	0.0941
Limburg	0.0402	0.0442	0.0851	0.0708
Flevoland	0.0057	0.0095	0.0154	0.0132
# Observations	174	950	2139	3263

Table 2. The distribution of graduates across choices, by personal, school, and spatial characteristics, respectively, in %, and the numbers of observation per category

	Choice			# Observations
	No education (%)	College (%)	University (%)	
All observations	5.60	29.28	65.12	3263
Personal characteristics				
Male	4.99	23.81	71.21	1344
Female	5.58	32.83	61.59	1919
Dutch	5.29	29.66	65.05	3139
Non-Dutch	6.45	15.32	78.23	124
Dutch parents	5.31	30.14	64.55	3052
Non-Dutch parents	5.69	14.22	80.09	211
Age ≤ 18	6.48	21.30	72.22	108
Age 19	4.82	26.37	68.82	2139
Age 20	6.36	35.05	58.58	833
Age > 20	6.01	38.80	55.19	183
GPA = 6	7.89	40.54	51.56	1216
GPA = 7	4.06	26.02	69.92	1576
GPA = 8	3.29	11.03	85.68	426
GPA = 9	0.00	0.00	100.00	45
Science & Technology profile	3.78	18.18	78.04	1243
Science & Health profile	4.69	34.69	60.61	490
Culture & Society profile	5.50	37.21	57.29	473
Economics & Society profile	7.38	35.76	56.86	1057
1998 Graduate	4.58	30.28	65.14	1420
1999 Graduate	5.41	30.52	64.07	924
2000 Graduate	6.42	25.90	67.68	919
High school characteristics				
Public school	6.27	24.00	69.73	750
Private school	5.32	23.05	71.63	282
Private religious school	5.02	31.60	63.38	2231
Spatial characteristics				
Groningen	4.25	27.41	68.34	259
Friesland	7.14	26.19	66.67	42
Overijssel	4.83	41.55	53.62	207
Gelderland	3.70	25.93	70.37	27
Utrecht	5.75	34.48	59.77	87
Noord-Holland	5.45	27.45	67.09	550
Zuid-Holland	6.69	29.21	64.11	1510
Zeeland, N-Brabant	1.63	33.22	65.15	307
Limburg	3.03	18.18	78.79	231
Flevoland	2.33	20.93	76.74	43

Table 3. Multinomial logit estimation results with robust standard errors[a]

Variable \ Choice	College		University	
	Estimate	Robust stnd. error	Estimate	Robust stnd. error
Constant	–3.2139	(6.9357)	–12.5973**	(6.1855)
Personal characteristics				
Male	–0.2175	(0.1836)	0.1669	(0.1606)
Non-Dutch	–0.6203	(0.4123)	–0.1881	(0.3598)
Parents non-Dutch	–0.3985	(0.3518)	0.6945*	(0.3029)
Age	0.2185	(0.1361)	–0.0603	(0.1312)
Log(GPA)	1.4127	(1.4101)	7.9758*	(1.4035)
Science & Technology profile	0.5452	(0.3380)	–0.1183	(0.3048)
Culture & Society profile	0.3929	(0.3238)	–0.3778	(0.2782)
Economics & Society profile	0.0868	(0.2314)	–0.6476*	(0.1901)
1999 Graduate	–0.3398	(0.2509)	–0.3228	(0.2499)
2000 Graduate	–0.4926**	(0.2056)	–0.3150***	(0.1877)
High school characteristics				
Private school	–0.3950	(0.3740)	–0.1700	(0.3133)
Public school	–0.9729*	(0.3394)	–0.4268*	(0.2460)
Log(school size)	–0.1468	(0.3939)	–0.2845	(0.3472)
Spatial characteristics				
Log(income per capita)	–0.8587	(2.8448)	1.2119	(2.6563)
Log(population density)	0.1415	(0.2107)	0.1198	(0.1750)
Log(college accessibility)	0.5658**	(0.2905)	—	—
Log(university accessibility)	—	—	0.2917**	(0.1494)
Groningen	1.8093*	(0.6899)	1.6110*	(0.6249)
Friesland	0.9520**	(0.4794)	0.8471**	(0.3938)
Overijssel	0.8325*	(0.2889)	0.7085**	(0.3412)
Gelderland	1.2234	(0.7886)	0.9536	(0.6553)
Utrecht	0.1552	(0.3245)	0.1527	(0.4834)
Noord-Holland	0.2210	(0.4100)	0.4222	(0.3821)
Zeeland, N-Brabant	1.8399*	(0.4867)	1.6840*	(0.4545)
Limburg	0.8272***	(0.4588)	1.1470*	(0.3617)
Flevoland	1.3756*	(0.6027)	1.9828*	(0.5729)
# Observations	3263			
% Correctly predicted[b]	66.99			
Log pseudo-likelihood	–2322.9451			
Pseudo-R^2	0.10			

[a] Significance at the 1, 5 and 10% level is indicated with *, ** and ***, respectively, and Huber-White adjusted standard errors are given in parentheses. The omitted categories for the dummy variables are concerned with a female Dutch student with Dutch parents who chose the Science and Health profile and graduated in 1998. The omitted high school characteristic is a private high school with a religious denomination, and the omitted spatial characteristic is the province of Zuid-Holland.

[b] The percentage correctly predicted outcomes is computed as follows. For each observation: (i) we estimate the probability of each outcome; (ii) the outcome with the highest estimated probability is the predicted one; (iii) the outcome is correctly predicted if the predicted outcome is the observed outcome; and (iv) the percentage of outcomes correctly predicted is the total number of correctly predicted outcomes divided by the total number of observations in the sample.

Table 4. Multinomial logit model, marginal effects

Variable	No education		College		University	
	Estimate	Robust stnd. error	Estimate	Robust stnd. error	Estimate	Robust stnd. error
Personal characteristics						
Male	–0.0026	(0.0067)	–0.0718*	(0.0201)	0.0745*	(0.0201)
Non-Dutch	0.0140	(0.0191)	–0.0781***	(0.0429)	0.0641	(0.0459)
Parents non-Dutch	–0.0168**	(0.0085)	–0.1609*	(0.0257)	0.1777*	(0.0272)
Age	–0.0007	(0.0054)	0.0536*	(0.0146)	–0.0529*	(0.0155)
Log(GPA)	–0.2607*	(0.0578)	–1.1861*	(0.0963)	1.4467*	(0.1104)
Science & Technology profile	–0.0041	(0.0124)	0.1403*	(0.0327)	–0.1362*	(0.0312)
Culture & Society profile	0.0051	(0.0129)	0.1609*	(0.0398)	–0.1661*	(0.0370)
Economics & Society profile	0.0191**	(0.0089)	0.1413*	(0.0293)	–0.1603*	(0.0273)
1999 Graduate	0.0149	(0.0117)	–0.0074	(0.0196)	–0.0075	(0.0221)
2000 Graduate	0.0166***	(0.0091)	–0.0378***	(0.0222)	0.0212	(0.0231)
High school characteristics						
Private school	0.0106	(0.0155)	–0.0439	(0.0376)	0.0333	(0.0371)
Public school	0.0275**	(0.0135)	–0.1036*	(0.0380)	0.0761**	(0.0366)
Log(school size)	0.0104	(0.0146)	0.0235	(0.0396)	–0.0339	(0.0396)
Spatial characteristics						
Log(income per capita)	–0.0270	(0.1109)	–0.3896	(0.2746)	0.4165	(0.2826)
Log(population density)	–0.0053	(0.0072)	0.0056	(0.0305)	–0.0003	(0.0305)
Log(college accessibility)	–0.0067***	(0.0035)	0.1103***	(0.0569)	–0.1037***	(0.0535)
Log(university accessibility)	–0.0089***	(0.0047)	–0.0535**	(0.0274)	0.0624**	(0.0320)
Groningen	–0.0404*	(0.0082)	0.0519	(0.0778)	–0.0115	(0.0776)
Friesland	–0.0257*	(0.0077)	0.0282	(0.0702)	–0.0025	(0.0699)
Overijssel	–0.0238*	(0.0076)	0.0315	(0.0533)	–0.0077	(0.0564)
Gelderland	–0.0284**	(0.0118)	0.0641	(0.0655)	–0.0357	(0.0609)
Utrecht	–0.0061	(0.0154)	0.0022	(0.0731)	0.0039	(0.0828)
Noord-Holland	–0.0140	(0.0131)	–0.0339	(0.0431)	0.0479	(0.0445)
Zeeland, N-Brabant	–0.0422*	(0.0067)	0.0434	(0.0547)	–0.0013	(0.0548)
Limburg	–0.0307*	(0.0073)	–0.0504	(0.0376)	0.0811**	(0.0357)
Flevoland	–0.0379*	(0.0052)	–0.0936**	(0.0447)	0.1315*	(0.0461)

Notes: Significance at the 1, 5 and 10% level is indicated with *, ** and ***, respectively, with Huber-White adjusted standard errors based on correlation among graduates attending the same high school given in parentheses. The marginal effects are computed for a female Dutch student, with at least one Dutch parent, who has chosen the science and technology profile, and who graduates in 1998 from a private school with a religious denomination, located in Zuid-Holland. All continuous variables are set to their sample means.

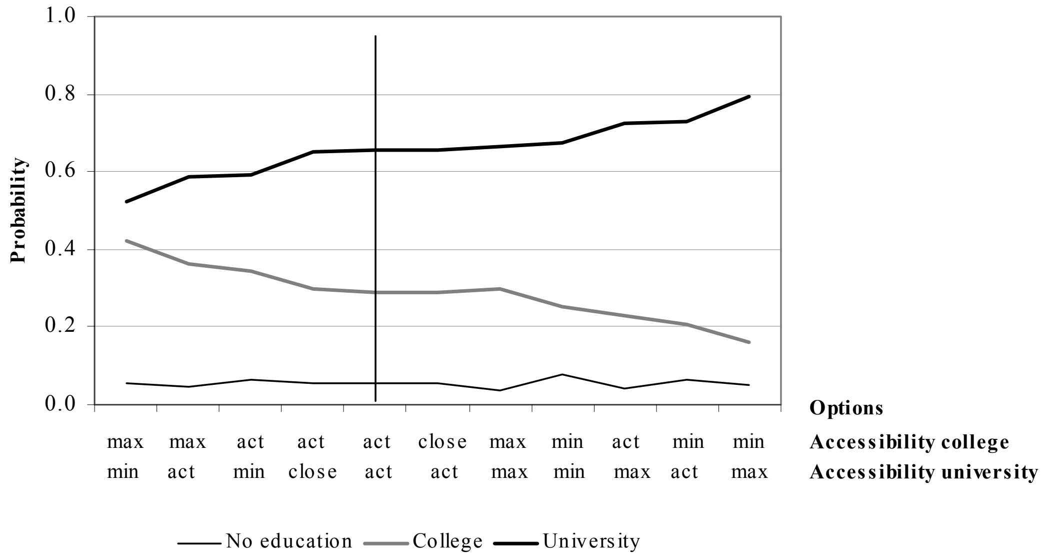

Fig. 1. Simulated choice probabilities for selected accessibility scenarios of professional colleges and universities

Notes: the abbreviations for the different options refer to accessibility fixed at the maximum value in the sample (max), at the minimum value in the sample (min), at the actual sample value (act), and at a recomputed value where one of the institutions is closed down (close).